Space Weather Technical Forecast

Issued on Wednesday, 14 August 2024 at 01:14 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: A chance of G1-G2/Minor-Moderate geomagnetic storms early day 1 (14 Aug). M-class flares likely with a slight chance of isolated X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with three M-class flares observed, the largest an M4.4 at 13/2344UTC originating from AR3784. There are ten sunspot regions visible on the disc. AR3780 situated in the southwest remains the largest region, displaying a complex magnetic structure with at least two weak delta spots. AR3784 in the northeast remains large and complex, now all contained within the penumbra of one singular spot therefore containing numerous delta spots in a somewhat unusual configuration. AR3786 has recently seen its smaller trailing spots consolidating themselves into one, slightly larger, spot. AR3777 is becoming increasingly difficult to analyse due to foreshortening as it rotates around the southwest limb. All other spots are currently small and simple.

A filament eruption was observed in the southwest of the disk around 13/0800UTC, with the subsequent CME being analysed as missing Earth. No further Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind parameters measured at L1 by DSCOVR/ACE were indicative of active CME magnetic cloud conditions, with a gradual exit. Solar wind speeds were slightly elevated at first, but have since eased to slow-ambient levels, around 380-400km/s. Density was above average at first with a peak of 19ppcc observed at 13/0116UTC, and has since dropped to average to below average levels. The Interplanetary Magnetic Field, Bt, was initially strong, peaking around 22nT at 13/0350UTC, before slowly easing to weak to end the period. The north-south component, Bz, was positive for the majority of the period, peaking at +17nT, before becoming predominantly weakly negative after 13/1624UTC, with a max southward deflection of -7nT. Phi angle was initially fairly neutral before becoming mostly positive (away from the Sun) after 13/0340UTC. Geomagnetic activity ranged between Quiet to Active levels (Kp1-4).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background below the S1 Minor Radiation Storm threshold. High energy electron flux (greater than 2MeV) observed at GOES16 were predominantly at background levels. The 24-hour fluence was steady and well below the Active threshold, with 1.05e6 integrated pfu observed at 14/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast, with M-class flares considered likely and a slight chance of an isolated X-class flare.

Solar Wind /Geomagnetic Activity: Influence from the CME magnetic cloud is continuing to wane, with all solar wind parameters declining close to slow-ambient levels. There remains a chance of the late arrival of up to two CMEs early on day 1 (14 Aug), though these are thought to have most likely

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been encompassed within the CME magnetic cloud experienced 12 Aug. Barring any CME influence, the fast wind from coronal hole 58 is likely to pass north of the Earth-Sun line with no appreciable enhancement expected, therefore solar winds should remain around slow-ambient levels.

Geomagnetic activity is expected to be mainly Quiet to Active (Kp2-4) through the start of the period. There remains a chance of up to two glancing CMEs early day 1 (14 Aug), therefore bringing a chance of G1-G2/Minor-Moderate Storming (Kp5-6), with a very slight chance of a G3/Strong storm (Kp7) interval. Geomagnetic activity then expected to decline later in the period to Quiet (Kp1-2) in the absence of any further CMEs.

Energetic Particles / Solar Radiation: A heightened risk of flare activity brings a chance of reaching/exceeding the S1 Minor Radiation storm level should any significant flares occur from active regions in the western hemisphere, though this risk reducing slightly from day 2. The high energy electron flux is forecast to be at mostly background levels. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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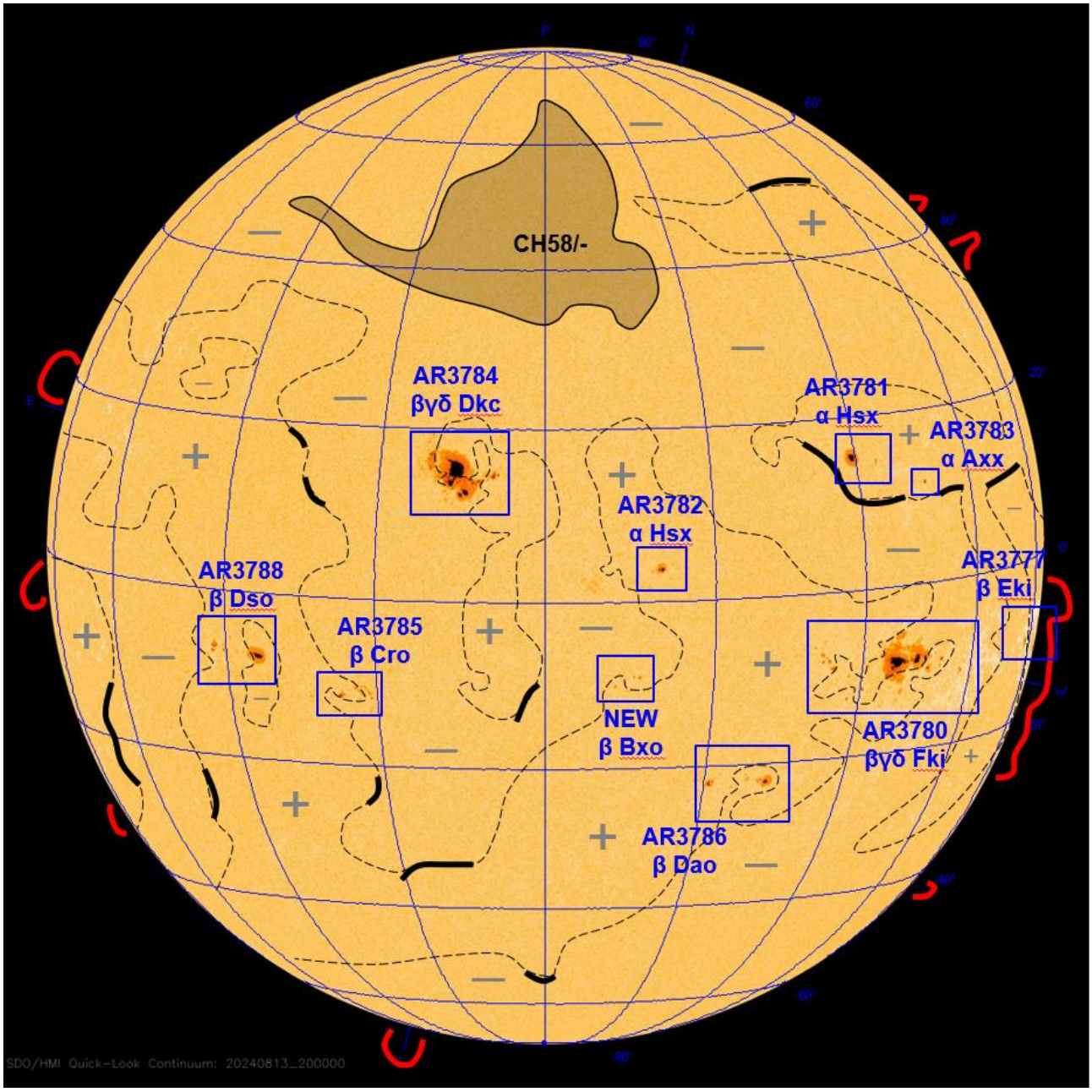
Figure 1. Solar Analysis Valid 13/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Influence from the CME magnetic cloud is continuing to wane, with all solar wind parameters experiencing a gradual decline to more slow-ambient levels. Solar winds are likely to stay this way through the period, although there remains some uncertainty whether two CMEs arrived within the magnetic cloud on 12 Aug or if their late arrival remains possible. These were the CMEs from the M4.5 flare from AR3777 at 09/2123 UTC, and the M5.3 flare from AR3780 at 10/0237UTC. These CMEs were expected to combine, with a joint arrival time around 13/0300UTC +/-8hrs. A discontinuity in the magnetic cloud observed around 13/0700UTC may be the very early arrival of these CMEs, which is currently thought to be the most likely situation given the previous large and fast CME acting to pull these CMEs through. On the other hand, a late arrival should be accounted for, and given the already elevated parameters may more easily trigger geomagnetic storms, though this is currently not the favoured situation.

No other Earth directed CMEs are expected in the period, with the fast wind from coronal hole 58 likely to pass north of the Earth-Sun line with no appreciable enhancement expected, therefore solar winds remaining slow-ambient.

Geomagnetic activity is expected to be mainly Quiet to Active (Kp2-4) through the start of the period. There remains a chance of up to two glancing CMEs early day 1 (14 Aug), therefore bringing a chance of G1-G2/Minor-Moderate Storming (Kp5-6), with a very slight chance of a G3/Strong storm (Kp7) interval. Geomagnetic activity then expected to decline later in the period to Quiet (Kp1-2) in the absence of any further CMEs.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	10	5	1
Strong	G3	No	2	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/2123	Partial	M4.5 flare	AR3777	633 km/s	13/0300 +8hrs	Either embedded in previous CME mag cloud or late.
Or 10/0645	Partial	M5.3 flare	AR3780	750 km/s	13/0300 +8hrs	Either embedded in previous CME mag cloud or late.

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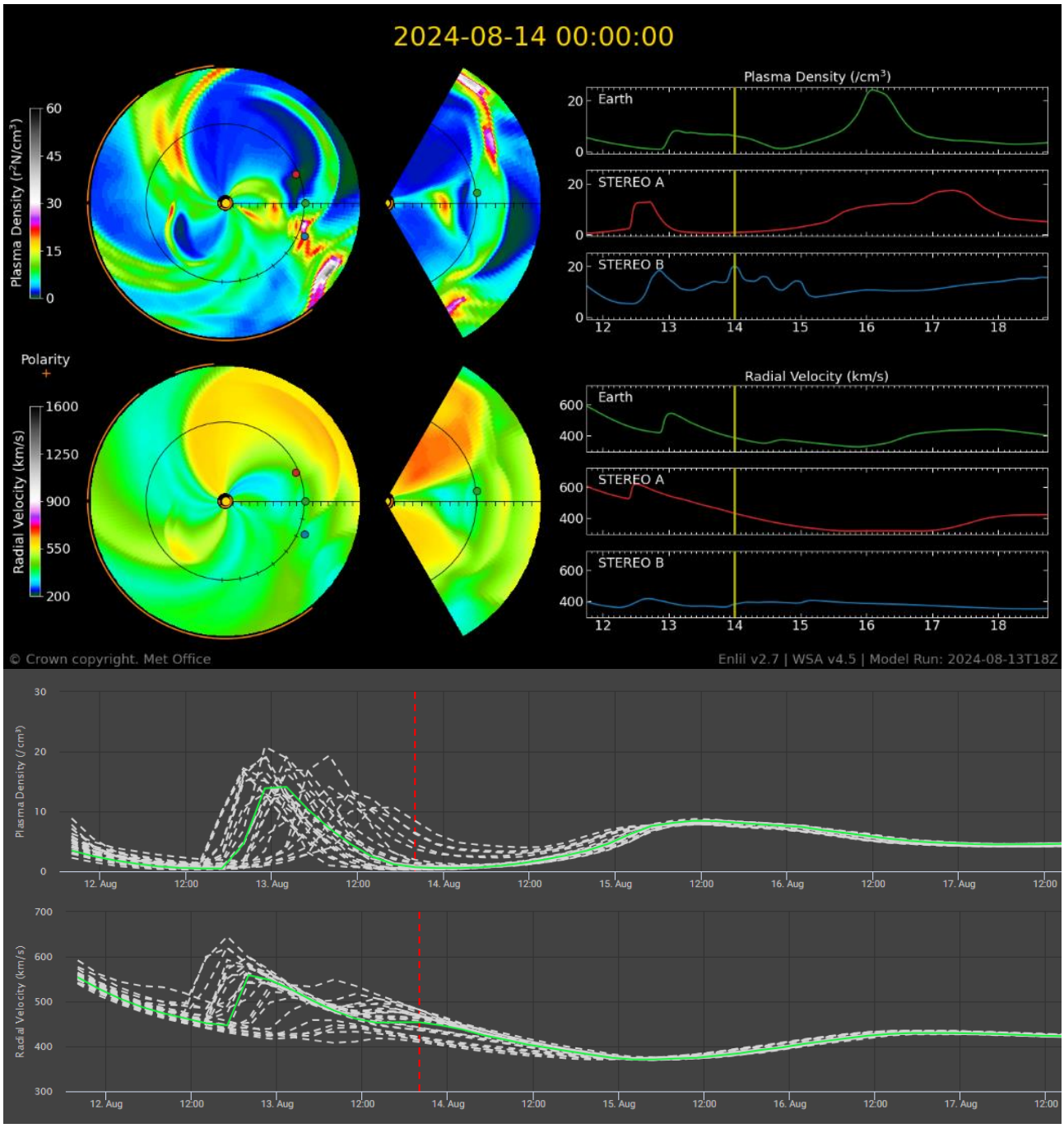
Figure 2: MOSWOC Enlil and Ensemble



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Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate with three M-class flares observed, the largest an M4.4 at 13/2344UTC originating from AR3784.

There are ten sunspot regions visible on the disc. AR3780 situated in the southwest remains the largest region, displaying a complex magnetic structure with at least two weak delta spots. AR3784 in the northeast remains large and complex, now all contained within the penumbra of one singular spot therefore containing numerous delta spots in a somewhat unusual configuration. AR3786 has recently seen its smaller trailing spots consolidating themselves into one, slightly larger, spot. AR3777 is becoming increasingly difficult to analyse due to foreshortening as it rotates around the southwest limb. All other spots are currently small and simple.

Further M-class flares are likely expected with a slight chance of an isolated X-class flare, these perhaps most likely from AR3780.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	70	70	70	70
Very Active	**R3 to R5 X Class**	No	20	20	20	20

Figure 3: GOES-16 & -18 X-ray flux

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Solar Radiation Storms - (High Energy Protons):
High energy proton flux, as observed by GOES-18, was at background throughout the period. Any strong flares will bring a chance of reaching/exceeding the S1 Minor Radiation storm level. The risk mainly from AR3780 and AR3777 currently in the western hemisphere, though this reducing by day 2 as AR3777 rotates further beyond the western limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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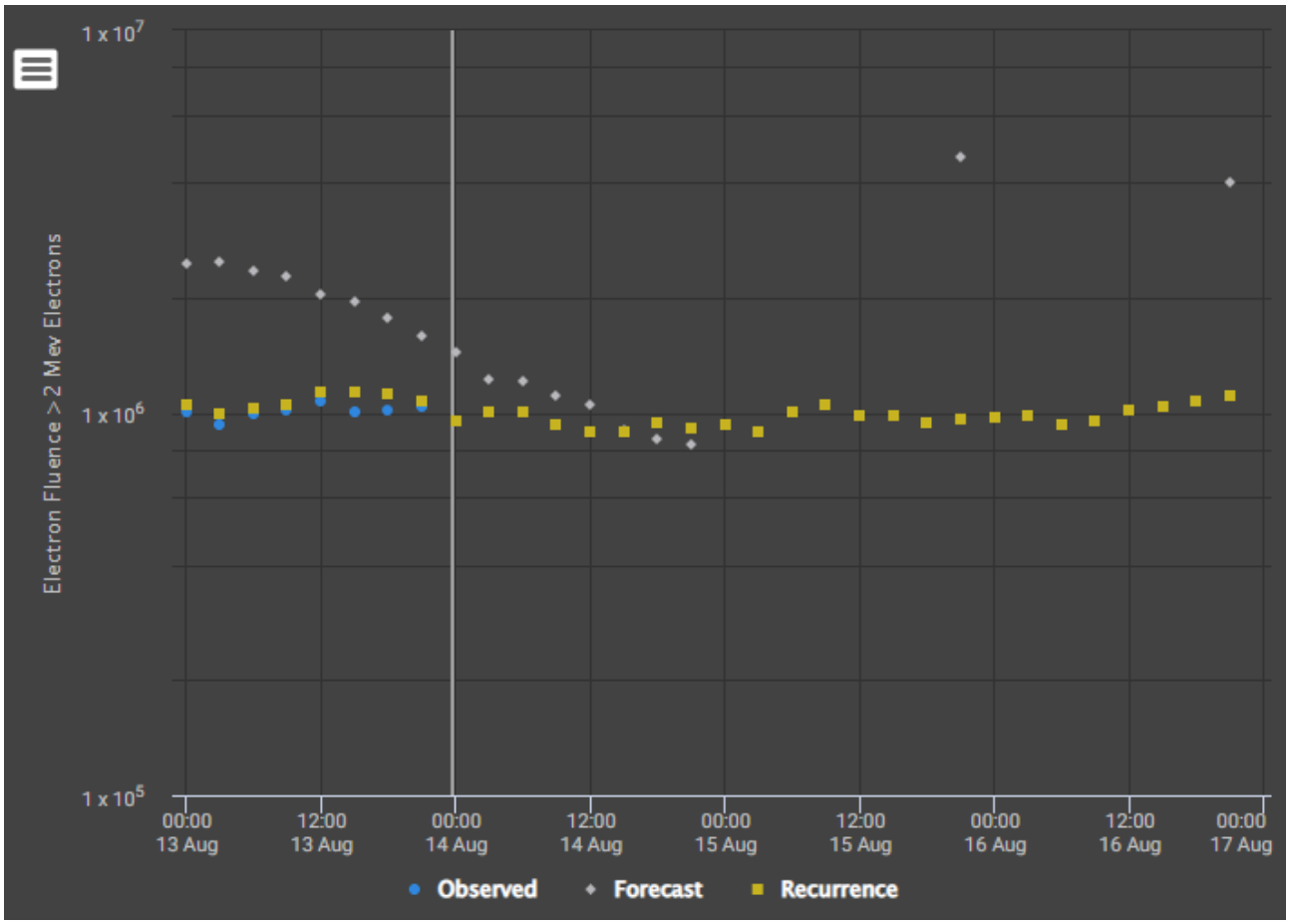
High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16, is currently at background. The recent Strong and Severe geomagnetic storming on 12 Aug may see electron flux at GEO increase in time to moderate or even high levels given the potential for electron transfer from currently more highly changed regions below GEO.

The associated 24hr electron fluence is therefore currently expected to remain below Active (1e8 integrated pfu) levels throughout but with reducing confidence into the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	10	10	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM



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